FUDMA JOURNAL OF ANIMAL PRODUCTION AND ENVIRONMENTAL SCIENCE

(*FUDMAJAPES*)

Volume 1 issue 1 2025

EFFECT OF MACA (*Lepidium meyenii*) POWDER SUPPLEMENTATION ON SERUM BIOCHEMISTRY OF YANKASA RAMS DURING HOT SEASON

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Keywords:
Maca,
Rams,
Serum,
Biochemistry

ABSTRACT

This study assessed the effect maca (*Lepium meyenii*) powder supplementation on serum biochemistry of yankasa rams raised during hot season. A total of 20 pubertal Yankasa rams were divided into four treatment groups of 0, 5, 10, 15g/ Kg powdered maca per kg diet with five (5) rams each per treatment in a Completely Randomized Design (CRD). At the end of experiment blood samples were collected and analyzed for liver function test, electrolytes and lipid. Data obtained were analyzed using analysis of variance of statistical analysis system were treatment means were separated using Duncan Multiple Range Test (DMRT). Blood samples were collected in a litheium heparin sample bottles and send to laboratory for serum biochemistry analysis. The result revealed that ALT and AST were significantly ($P<0.05$) difference. With the exception of potassium all other plasma electrolytes were not significantly ($P>0.05$) differences. Maca supplement has shown significant effect on plasma cholesterol and HDLP. It could be concluded that maca supplementation from 5–15g/kg diet remarkably enhances liver function tests with a marked hepatoprotective activities. Supplementation of maca across the treatment shown no adverse effect in plasma electrolytes. It is therefore, recommended that maca supplementation up to 15g/kg in diet is safer and farmers and livestock nutritionist can use it in livestock as natural feed additives and blood metabolites enhancers without deleterious effect.

Citation: Gaddafi, S., Yahaya, M.A., and Garba, M.G. (2025). EFFECT OF MACA (*Lepidium meyenii*) POWDER SUPPLEMENTATION ON SERUM BIOCHEMISTRY OF YANKASA RAMS DURING HOT SEASON. *FUDMA Journal of Animal Production & Environmental Science*, 1(1), 71-76. https://doi.org/10.33003/japes.2025.v1i1.71-76

INTRODUCTION

Climate change and alteration of weather condition refers to a change in climate which is attributed directly or indirectly to human activities and natural variability that alters the composition of the global atmosphere over a long period of time (IPCC, 2007). The variations in climate parameters affect different sectors of the economy, such as agriculture, livestock production, heath, water, energy, e.t.c. According to Intergovernmental Panel on Climate Change, Africa is one of the most vulnerable continents to climate change and climate variability (IPCC, 2007). In mammals, global warming and excessive heat stress causes significant increases in body temperature above the physiological homoeothermic point (hyperthermia) with consequent organic suffering (heat stress) that leads to impaired physiological and reproductive activities (Raffaela, 2019).

Blood is constituted by cells and the plasma, which is the fluid portion. It functions to transport nutrients, regulates bio-functions, protect the entire animal body as well as exercise homeostatic control (Nasyrova *et al.,* 2006). The usefulness of blood in assessing the quality of foods and feed additives were long been underscored by various researchers. Blood is therefore, a fastest and readily available means of evaluating chemical and nutritional health status of animals in feeding trail (Aderemi, 2004). Presence of metabolites and other constituents of stress could be investigated through blood examination thus could be occasioned by nutrition, environment

or disease agent. In livestock production, maintaining optimal serum biochemical parameters is crucial for ensuring animal health, reproductive efficiency, and economic viability.

Maca is a vegetable root native to Peru. Its scientific name is *Lepidium meyenii* and also known in Hausa language as "*Sauyar Maca*" or "*Albasar tamoji*" while Yaroba Language it known as ' *'Isu baka*'' (Gaddafi *et al.,* 2023). In rodent, scientific studies have been shown that maca improves sperm production and testosterone levels without significantly altering serum biochemistry (Ganzales *et al.,* 2002). However, extrapolating these findings to ruminant animals like rams may not be appropriate due to differences in metabolism and digestive physiology. Similarly sharma *et al.* (2018) studies suggest that existing studies of maca in ruminant animal were limited and focused mostly on its aphrodisiac effects rather than systemic biochemical impact. Therefore, this study aims to fill this knowledge gap by assessing the effect of maca supplementation on serum biochemistry in Yankasa rams, this will provides valuable insights for livestock nutritionists and farmers seeking safer and natural reproductive enhancers.

MATERIALS AND METHOD

Experimental site

This experiment was carried out at Small Ruminant unit of Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsin-Ma, Katsina State. The site lies in the sudano-sahelian savanna between latitude 12º27`18`N and 7º29`29`E and 605 meters above sea level with an annual average rainfall of 700mm.

Experimental Feed Preparation

All the feed materials that were used in the experimental diets' preparation was purchased from selling and processing centers in Dutsin-Ma. Maize and cotton seed cake was ground and packed in sacks for experimental diets compounding. Whereas groundnut hay was chopped before mixing, other feed ingredients such as wheat offal, maize bran, bone meal, and table salt were purchased from the different centers in Dutsin-Ma town.

Diet was formulated to meet the dietary requirement for breeder rams and pregnancy goats according to dietary recommendation of NRC, (2000) for tropical rams.

Experimental design: this experiment consists of 20 pubertal Yankasa rams which was divided into four treatment groups of 0, 5, 10, 15g/ Kg powdered maca with five (5) rams each per treatment in a completely randomized design (CRD).

Preparation of Maca Powder

Fresh maca was procured from herbal vendor in Dutsin-Ma Market, the maca was washed by tap water, and the fibrous roots was separated from the top. the roots was sliced to 2-cm-thick pieces and sun dried 72 hours at Animal Science Laboratory, Department of Animal Science, Federal University Dutsin-Ma to the moisture content of 6-9%. The maca slices was ground into powders, sieved through 2-mm wire-mesh, and stored at room temperature before use.

Data collection and analysis

Serum biochemical determination

Blood and serum samples was collected at the end of experiment (12 weeks post trail) by using sterile syringe and needle using jugular venipuncture of three (3) overnight four fasted rams from each treatment. A quantity of 5 ml of blood were collected into labelled sterile sample bottles without anticoagulant and were used for the serum biochemical analysis. The sample was centrifuged at 3000 rpm for 15 minutes. Separated serums was stored frozen at -20ºC in sample bottles without anticoagulant until the time of analysis. The serum biochemical indices to be determined were serum Albumin, globulin, total protein, alkaline phosphate (ALP), Alanine aminotransferase (ALT), Aspartate aminotransferase (AST). The data obtained was subjected to analysis of variance (ANOVA) using the general linear model of statistical analysis system (SAS) were treatment means were separated using Duncan Multiple Range Test (DMRT)

RESULT AND DISCUSSION

Effect of Maca Supplements on Liver function test of Yankasa rams

It is very essential to evaluate the liver function since liver play a central role in metabolism, detoxification and protein synthesis. This helps in diagnosing diseases, metabolic disorders,

impact of environmental stressors and monitoring nutritional status and dietary adequacy of Yankasa rams during this experiment. The table below represent liver function test of Yankasa rams supplemented maca-diet. The result showed that there were no significant (P>0.05) differences in plasma protein were total protein, albumin and globulin were not statistically different. Thus, T4 had the higher numerical values of total protein and globulin. The result revealed that there were significant (P<0.05) differences in alanine aminotransferase (ALT); higher ALT values were recorded in T3 (6.25µ/l) followed by T4 (5.38µ/l), T1 (5.01µ/l) while T2 exhibit lower ALT values (4.77µ/l). The ALT values obtained in this study collaborates with the ALT values of Yankasa rams of 4.50 – 6.50 µ/l) reported by Garba and Adeola, (2022). Aruwayo *et al.* (2011) reported that the level of serum glutamic oxaloacetic transaminase (SGOT) otherwise known as alanine aminotransferase is useful for the diagnosis of cases of myocardial infections, hepatocellular disease, skeletal muscle, disorders, trauma or diseases affecting skeletal muscle and various haemolytic conditions.

No significant (P>0.05) changes in alkaline phosphatase (ALP) were observed in this study. ALP values obtained in this study fall within the ALP values reported by Garba and Adeola, (2022) and Saleh and Sanusi (2019) of healthy Yankasa rams. Elevated ALP values occur in biliary obstruction or bone metabolism disorder (Kaneko *et al.,* 2008).

The result was however, showed significant (P<0.05) changes in aspartate aminotransferase. There were marked decreasing AST levels with increasing level of maca in this study; were T1 had the highest AST (14.89 µ/l) values followed by T2 (12.49 µ/l), T3 (12.26 µ/l) and T4 (9.87 µ/l). AST is the liver enzymes used to assess hepatic function. Therefore, the AST values obtained in this study signifies that maca supplementation does not adversely affect liver function and may even have hepatoprotective effects because Kaneko *et al.* (2008) states that elevated levels of AST marker indicate liver damage or disease.

No significant (P>0.05) differences were observed in total bilirubin and conjugate bilirubin. The non-elevated increases of bilirubin observed in this study suggested that Yankasa rams fed maca-diet have no severe haemolysis and liver dysfunction since Kaneko *et al.,* (2008) suggest liver dysfunction and haemolysis as a result of high levels of bilirubin.

Table 1: Effect of Maca Supplements on Liver function test of Yankasa rams

Parameters	T1	T2	T3	T4	SEM	LOS
TP (g/dl)	6.35	6.91	6.34	6.87	0.69	NS
Albumin (g/dl)	4.27	4.39	4.65	4.08	0.32	NS
Globulin (g/dl)	2.09	2.53	1.69	2.81	0.57	NS
ALT (µ/l)	5.01^{b}	4.77^{a}	6.25^{a}	5.38^{a}	0.50	*
ALP (µ/l)	15.82	17.09	17.68	17.21	1.60	NS
AST (µ/l)	14.89^{a}	12.49^{ab}	12.26^{ab}	9.87^{b}	1.85	*
Total bilirubin	1.42	0.99	1.39	0.86	0.34	NS
Conj. Bilirubin	0.36	0.27	0.44	0.31	0.21	NS

TP = Total protein, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, AST = Aspartate aminotransferase

Effect of Maca supplements on Kidney function test Yankasa rams

The result on the effect of maca on kidney function test (electrolytes) were presented in table below. The kidney function test is very essential to get insight on how the animal kidney regulate fluid balance, electrolyte, and waste excretion.

The result showed that blood urine nitrogen (BUN) and creatinine were not significant (P>0.05) differences. The values obtained for BUN and creatinine were fall within the values reported by Garba and Adeola (2022) for Yankasa rams. This indicates normal kidney functions since elevated levels of BUN and creatinine indicates impaired kidney function (Radostits *et al.*, 2007). With the exception of

potassium (K^+) ($P<0.05$) the plasma electrolytes were not significantly ($P<0.05$) differences in this study. The group supplemented maca have demonstrated moderate K^+ levels. Very low K^+ or high imbalances can signal renal or metabolic disorders (Radostits *et al.,* 2007).

Table 2: Effect of Maca supplements on Kidney function test Yankasa rams

Parameters	T1	T2	T3	T4	SEM	LOS
BUN (nmol/L)	11.32	11.91	11.87	12.09	0.77	NS
Creatinine (µmol/L)	113.0	118.20	110.50	113.70	5.32	NS
Na (nmol/L)	126.5	130.70	126.40	134.40	3.75	NS
K^+ (nmol/L)	2.73^b	3.21^{ab}	3.58^a	3.28^{ab}	0.28	*
Chloride (nmol/L)	1.72	1.80	2.19	2.15	0.29	NS
P (nmol/L)	1.25	1.53	1.32	1.36	0.40	NS
HCO_3 (nmol/L)	25.89	25.76	25.89	25.86	1.162	NS

BUN = Blood urea nitrogen, Na = Sodium, K^+ = Potassium, P = Phosphorous, HCO_3 = Biocarbonate, SEM = Standard error mean, LOS = Level of significance

Effect of Maca Supplement on Lipid Profile Yankasa rams

Evaluation of lipid profile is very essential for assessing metabolism for energy production and cellular function. The table below present the result on the effect of maca supplementation on lipid profile of Yankasa rams. The result revealed significant ($P<0.05$) difference in total cholesterol were T1 had higher cholesterol level ($62.52mg/d^{-1}$) while T4 had the lowest value 4.8.43 mg/d^{-1}. These findings support the study carried out in poultry fed maca which have been reported to have lower cholesterol and triglyceride levels which may be linked to maca`s bioactive compounds. Herdt (2000) revealed that high levels of cholesterol indicate metabolic syndrome or dietary imbalances.

In 2024, Mahdy studies using maca in rams showed that triglyceride and cholesterol were decreased by maca treatments (Mahdy *et al.,* 2024). This also collaborates with findings of Wan *et al.* (2018) concordant to our present results, Olgun *et al.* (2022) who reported that supplementation of 0, 0.5, 1.0, 1.5, 2.0 and 2.5g/kg diet could appear to reduce cholesterol and triglyceride. The result showed that there were no significant ($P<0.05$) differences in triglycerides and low-density lipoprotein. This studies suggest thatat maca can be used as natural feed additives in reducing the chance of atherosclerosis and coronary artery diseases risk since elated level of LDL contributes to plaque buildup in arteries which in turn causes coronary artery disease, stroke and peripheral artery disease. The high-density lipoprotein showed significant ($P<0.05$) differences. It is very important to note that increases maca supplementation levels tend to elevate HDLP in this study. This further proved that maca has hepatoprotective properties. Because elevated HDLP levels helps to remove excess cholesterol from arteries and transports it to the liver for excretion. It also reduces endothelial damage and plaque instability as opined by Rader and Hovingh (2014).

Table 3: Effect of Maca Supplement on Lipid Profile Yankasa rams

Parameters	T1	T2	T3	T4	SEM	LOS
Cholesterol (mg/d^1)	62.52^a	63.43^a	59.38^a	48.43^b	3.57	*
Triglyceride (mgd^1)	18.74	18.28	15.52	17.89	1.32	NS
LDLP (mg/d^1)	12.57	15.33	10.91	10.00	4.55	NS
HDLP (mg/d^1)	56.65^b	59.38^a	62.52^a	62.52^a	3.89	*

LDLP = low density lipoprotein, HDLP = High density lipoprotein, SEM = Standard error mean, LOS = Level of significant

CONCLUSION

The result from this study could be concluded that maca supplementation from 5 – 15g/kg diet remarkably enhances liver function tests with a marked hepatoprotective activities. Supplementation of maca across the treatment shown no adverse effect in plasma electrolytes. Maca supplementation at 10 and 15g/kg have greatly demonstrated decrease in plasma concentration of cholesterol and high density lipoprotein. It is therefore, recommended that maca supplementation up to 15g/kg in diet is safer and farmers and livestock nutritionist can used it in livestock as natural feed additives and blood metabolites enhancers without deleterious effect.

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